

1 What is claimed is:

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1. A spin-valve sensor, comprising:
2 a sensing layer formed of a first ferromagnetic material;
3 a reference layer formed of a second ferromagnetic material;
4 a spacer layer interposed between the sensing layer and the reference layer,
5 the spacer layer formed of a nonferromagnetic conducting material;
6 pinning layers disposed to one side of the reference layer, the pinning
7 layers comprising at least two antiferromagnetic (AFM) Ni-Mn films.

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9 2. The spin-valve sensor of claim 1, wherein the at least two AFM films
10 comprise a first AFM film in contact with the reference layer and a second AFM film not
11 in contact with the reference layer.

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13 3. The spin-valve sensor of claim 2, wherein the first AFM film has a higher
14 Mn content than the second AFM film.

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16 4. The spin-valve sensor of claim 2, wherein the first AFM Ni-Mn film has a
17 Mn content in the range of between about 54 and about 60 at%.

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19 5. The spin-valve sensor of claim 2, wherein the first AFM Ni-Mn film has a
20 Mn content of about 57 at%.

21 6. The spin-valve sensor of claim 2, wherein the second AFM film has a Mn
22 content in a range of between about 49 and about 54 at%.

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24 7. The spin-valve sensor of claim 2, wherein the second AFM film has a Mn
25 content of about 50 at%.

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1 8. The spin-valve sensor of claim 2, wherein the first AFM Ni-Mn film has a
2 thickness in a range between about 25 and about 225 Å.

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4 9. The spin valve sensor of claim 2, wherein the first AFM Ni-Mn film has a
5 thickness of about 125 Å.

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7 10. The spin-valve sensor of claim 2, wherein the second AFM Ni-Mn film
8 has a thickness in the range of between about 25 and about 225 Å.

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10 11. The spin-valve sensor of claim 2, wherein the second AFM Ni-Mn film
11 has a thickness of about 125 Å.

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13 12. The spin-valve sensor of claim 2, wherein the first and second AFM Ni-
14 Mn films have a total thickness in a range between about 200 and about 300 Å.

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16 13. The spin-valve sensor of claim 2, wherein the first and second AFM Ni-
17 Mn films have a total thickness of about 250 Å.

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19 14. A spin-valve sensor, comprising:
20 a sensing layer formed of a first ferromagnetic material;
21 a reference layer formed of a second ferromagnetic material;
22 a spacer layer interposed between the sensing layer and the reference layer,
23 the spacer layer formed of a nonferromagnetic conducting material;
24 pinning layers disposed to one side of the reference layer, the pinning
25 layers comprising at least two antiferromagnetic (AFM) Pt-Mn films.

- 1 15. The spin-valve sensor of claim 14, wherein the at least two AFM films
- 2 comprise a first AFM film in contact with the reference layer and a second AFM film not
- 3 in contact with the reference layer.
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- 5 16. The spin-valve sensor of claim 15, wherein the first AFM film has a
- 6 higher Mn content than the second AFM film.
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- 8 17. The spin-valve sensor of claim 15, wherein the first AFM Pt-Mn film has
- 9 a Mn content in the range of between about 47 and about 53 at%.
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- 11 18. The spin-valve sensor of claim 15, wherein the first AFM Pt-Mn film has
- 12 a Mn content of about 52 at%.
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- 14 19. The spin-valve sensor of claim 15, wherein the second AFM Pt-Mn has a
- 15 Mn content in the range of between about 44 and about 47 at%.
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- 17 20. The spin-valve sensor of claim 15, wherein the second AFM Pt-Mn has a
- 18 Mn content of about 45 at%.
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- 20 21. The spin-valve sensor of claim 15, wherein the first AFM Pt-Mn film has
- 21 a thickness in a range between about 25 and about 225 Å.
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- 23 22. The spin-valve sensor of claim 15, wherein the first AFM Pt-Mn film has
- 24 a thickness of about 125 Å.
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- 26 23. The spin-valve sensor of claim 15, wherein the second AFM Pt-Mn film
- 27 has a thickness in a range between about 25 and about 225 Å.

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2 24. The spin-valve sensor of claim 15, wherein the second AFM Pt-Mn film
3 has a thickness of about 125 Å.

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5 25. The spin-valve sensor of claim 15, wherein the first and second AFM Pt-
6 Mn films have a total thickness in a range between about 150 and about 250 Å.

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8 26. The spin-valve sensor of claim 15, wherein the first and second AFM Pt-
9 Mn films have a total thickness of about 200 Å.

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11 27. A spin-valve sensor, comprising:
12 a sensing layer formed of a first ferromagnetic material;
13 a reference layer formed of a second ferromagnetic material;
14 a spacer layer interposed between the sensing layer and the reference layer,
15 the spacer layer formed of a nonferromagnetic conducting material;
16 pinning layers disposed to one side of the reference layer, the pinning
17 layers comprising at least two antiferromagnetic (AFM) films selected from the
18 same Mn-based alloy system.

1 28. A disk drive system, comprising:
2 a spin-valve sensor, the spin-valve sensor comprising:
3 a sensing layer formed of a first ferromagnetic material;
4 a reference layer formed of a second ferromagnetic material;
5 a spacer layer interposed between the sensing layer and the
6 reference layer, the spacer layer formed of a nonferromagnetic conducting
7 material; and
8 pinning layers disposed to one side of the reference layer, the
9 pinning layers comprising at least two antiferromagnetic (AFM) films
10 selected from the same Mn-based alloy system;
11 an actuator for moving the spin-valve sensor across the magnetic disk so
12 the spin-valve may access different regions of written data on the magnetic disk;
13 and
14 a detector coupled to the spin-valve sensor for detecting changes in
15 resistance of the sensor caused by rotation of the magnetization of the sensing
16 layer relative to the fixed magnetization of the reference layer in response to
17 magnetic fields from the written data.